

Sociodemographic characteristics and emergency department visits and inpatient hospitalizations for atopic dermatitis in Ontario: a cross-sectional study

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Abstract

Background: Some jurisdictions experience sociodemographic disparities in atopic dermatitis care, including emergency department visits, but data from Canada are limited. Our objectives were to estimate the prevalence of atopic dermatitis in Ontario and to identify sociodemographic factors associated with emergency department visits and hospitalizations for this condition.

Methods: We conducted a cross-sectional analysis of patients in the Electronic Medical Record Primary Care database linked with administrative health data for Ontario, Canada. We estimated period prevalence and health service utilization for atopic dermatitis from 2005 to 2015. We used multivariable log-binomial regression to calculate adjusted risk ratios (RRs) and 95% confidence intervals (CIs) for associations between local dermatologist density and the proportion of emergency department visits and hospitalizations for atopic dermatitis.

Results: Among 249984 patients, we identified 7812 with atopic dermatitis (period prevalence 2005–2015: 3.1%). Almost all physician visits for atopic dermatitis were to primary care physicians (> 99%). For every additional dermatologist per 100000 population, the proportions of emergency department visits and hospitalizations for atopic dermatitis increased by 29% (RR 1.29, 95% CI 1.05–1.57). This relationship occurred in and around Toronto but was not consistent across the province.

Interpretation: In Ontario, higher dermatologist density was not associated with lower emergency department utilization and hospitalization for atopic dermatitis; the association varied in different locales with similar dermatologist densities. Strategies to improve access to care for atopic dermatitis should be tailored to local contexts.

Atopic dermatitis, commonly called eczema, is a chronic skin condition that is common in children and adults.^{1,2} Most patients can be treated successfully with topical therapy, including emollients and corticosteroids that can be prescribed in primary care.³ Treatment escalation to systemic therapy or phototherapy, typically administered by dermatology specialists, is sometimes required for dermatitis that is more refractory or severe.⁴ Ideally, atopic dermatitis care is administered in ambulatory settings; emergency department (ED) visits and hospitalizations for atopic dermatitis should be rare and avoided whenever possible.^{5,6}

Sociodemographic disparities have been identified with respect to atopic dermatitis care and outcomes. In the United Kingdom, people with lower socioeconomic status are less likely to be prescribed more potent topical corticosteroids.⁷ In the United States, low socioeconomic status and not having health insurance are predictors of more ED visits and inpatient admissions for atopic dermatitis.^{5,6} Studies of health care

utilization for atopic dermatitis in Canada are lacking, but sociodemographic disparities in care are likely to occur, given that sex, geography and socioeconomic status play a role in other health disparities in Ontario.⁸

Access to dermatologic care in Ontario is also highly variable. Toronto has 5.6 dermatologists per 100000 population, and the wait time for consultation is 4.4 weeks.⁹ Nearby Niagara has 1.3 dermatologists per 100000 population, and the corresponding wait time is 13 weeks.⁹ Parts of Northern Ontario have only 0.6 dermatologists per 100000 population and a wait time of 34 weeks.⁹

Competing interests: See the end of the article.

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Our main objectives were to estimate the prevalence of atopic dermatitis in Ontario from 2005 to 2015 and identify factors associated with ED visits and hospitalizations for this condition. We hypothesized that a lower density of dermatologists practising in a region would be associated with a higher proportion of ED visits and hospitalizations for atopic dermatitis.

Methods

Study design and setting

We conducted a cross-sectional study using linked electronic medical record and administrative health data in Ontario, Canada.

Ontario is Canada's most populous province, with a population of 13 707 118 in 2015.¹⁰ Until 2021, Ontario's health system was organized into 14 geographic units called Local Health Integration Networks (LHINs), which coordinated health care resources, including hospitals (Appendix 1, available at www.cmajopen.ca/content/10/2/E491/suppl/DC1, Figure S1). Physician visits (primary care and specialist), ED visits and hospitalizations are all government-funded for Ontario residents enrolled in the Ontario Health Insurance Plan (OHIP).

We have reported this manuscript in accordance with the Reporting of Studies Conducted Using Observational Routinely Collected Health Data (RECORD) statement.¹¹

Study population

We derived the study population from the Electronic Medical Record Primary Care database (EMRPC; also known as EMRALD). We used data from 2005 to 2015, the last full year for which EMRPC data were available. The EMRPC database contains clinical notes, problem lists, prescribed medications and specialist consultation notes for 43 family practice clinics that have physician and patient characteristics representative of the general population of Ontario.¹² EMRPC practices are located in every LHIN but LHIN 14 (North West); however, patients rostered to EMRPC physicians live in each of the 14 LHINs.

We used the study population from the validation study for atopic dermatitis case definitions in routinely collected health databases in Ontario,¹³ which included patients of all ages rostered to family physicians in EMRPC practices. The validation study excluded patients with an invalid or missing date of birth, health card number or sex; patients with less than 2 years of data in the EMRPC; and patients who had no clinic visits in the 2 years before the load date of the electronic medical record (Appendix 1, Figure S2). Among the remaining patients, we identified those diagnosed with atopic dermatitis using a logistic regression algorithm on text in the EMRPC records that had a sensitivity of 67% and a positive predictive value of 76%.¹³

Data sources

All data sets were linked using unique encoded identifiers and analyzed at ICES, an independent, nonprofit research institute (Appendix 1). Because we included only EMRPC patients with a valid health card number, linkage was considered to be 100%. We derived patient age, sex and location of residence

from the Registered Person Database, which is linked with Canadian census information to derive socioeconomic status based on neighbourhood income^{14,15} and marginalization index.¹⁶ These census-derived variables were ascertained at the level of the dissemination area — a small area composed of 1 or more neighbouring dissemination blocks, with a population of 400 to 700 persons.

We derived information about physician visits from the OHIP database, which includes billing codes and truncated *International Classification of Diseases, 9th Revision* (ICD-9), diagnostic codes for physician encounters. The Canadian Institute for Health Information (CIHI) Discharge Abstract Database (DAD) includes ICD-9 and -10 diagnostic codes associated with inpatient hospitalizations. The National Ambulatory Care Reporting System (NACRS) database includes ICD-10 diagnostic codes associated with ED visits. We used data from the OHIP, CIHI-DAD and NACRS databases, along with the Johns Hopkins Adjusted Clinical Group (ACG) system, to estimate patients' comorbidity and morbidity.¹⁷ We derived physician specialty and practice addresses from the ICES physician database.

Exposures

The primary exposure variable was the density of practising dermatologists in the LHIN of patient residence. We calculated dermatologist density in 2015 by dividing the number of dermatologists with their primary practice address in a particular LHIN by that LHIN's total population, multiplied by 100 000.

Other exposures of interest included patient age, sex and rurality of residence (urban, small town or rural), as well as neighbourhood socioeconomic^{14,15} and marginalization indices (including residential instability, material deprivation, dependency and ethnic concentration; quintile 1: low to quintile 5: high).¹⁶

We examined continuity of primary care as measured by the usual provider of care index, which is based on physician visits extracted from the OHIP database. We calculated the usual provider of care index for a 2-year period from Apr. 1, 2013, to Mar. 31, 2015. We did this by dividing the total number of core primary care visits a patient made to their own physician (i.e., the rostering physician) by their total number of core primary care visits. (Core primary care visits were visit types where 80% or more of all billings for that visit code were submitted by primary care physicians and the code represented $\geq 0.1\%$ of all billings by primary care physicians.¹⁸) We restricted "core primary care visits" to those made to family physicians, community medicine physicians or pediatricians for core primary care (see Appendix 1 for codes for core primary care services). Low continuity referred to patients who made fewer than 50% of their visits to their rostering physician.

We assessed comorbidity over a 2-year period (Jan. 1, 2014, to Dec. 31, 2015) using the ACG number of aggregate diagnosis groups (www.hopkinsacg.org): 0 to 4 (no or low comorbidity), 5 to 9 (moderate comorbidity) and 10+ (high comorbidity).

We measured morbidity using the ACG resource utilization band (www.hopkinsacg.org): 0 to 1 (nonuser or healthy user), 2 (low morbidity), 3 (moderate morbidity) and 4+ (high morbidity).

Outcomes

Our outcomes were the use of different health care resources for atopic dermatitis. We assessed visits to specialists and primary care using OHIP physician billing codes; each visit was associated with a single ICD-9 diagnostic code. In NACRS, ED visits are associated with up to 10 ICD-10 diagnostic codes. In DAD, hospital admissions are associated with up to 25 ICD-10 diagnostic codes, including the most responsible diagnosis and secondary and significant comorbid diagnoses. Codes used to identify visits for atopic dermatitis are given in Appendix 1.

Statistical analysis

For each utilization type, we calculated the proportion of use associated with atopic dermatitis by dividing the number of encounters of each type associated with atopic dermatitis by the patient's total number of encounters of each type (either ED visits and hospitalizations or total physician visits) over the study period (2005 to 2015). For example, our primary outcome was the proportion of ED visits and hospitalizations associated with atopic dermatitis. For each patient, we divided the number of ED visits and inpatient hospitalizations associated with atopic dermatitis by each patient's total number of ED visits and inpatient hospitalizations. Other outcomes, calculated similarly, were as follows: the proportion of all physician visits associated with atopic dermatitis, and the proportion of all physician visits that were primary care visits (family medicine, community medicine and pediatrics), dermatologist visits and specialist visits (including dermatologist visits) associated with atopic dermatitis.

We calculated the period prevalence (2005–2015) of atopic dermatitis among eligible patients in the EMRPC from 2005 to 2015 overall, and among children (< 18 yr) and adults (≥ 18 yr). We calculated descriptive characteristics on Dec. 31, 2015, among patients with and without atopic dermatitis. We calculated mean annual proportions of health service utilization associated with atopic dermatitis during the study period by dividing the number of encounters for atopic dermatitis by the total number of encounters and the number of years patients were eligible for OHIP coverage from 2005 to 2015.

We used univariable and multivariable log-binomial regression to calculate risk ratios (RRs) and 95% confidence intervals (CIs) for associations between exposures and outcomes (proportions of ED visits and hospitalizations, physician visits, primary care visits, dermatologist visits and specialist visits associated with atopic dermatitis). Each multivariable model included dermatologist density (primary exposure, continuous); age (continuous); sex; continuity of primary care (2014–2015: not rostered, low, high); whether the patient had seen a dermatologist for atopic dermatitis; rurality of residence; ACG comorbidity score (low [0–4], moderate [5–9], high [≥ 10]); ACG morbidity score (nonuser or healthy user, or low, moderate, high morbidity); and neighbourhood income, dependency, deprivation, ethnic concentration and residency instability quintiles.

We included continuity of primary care and dermatology visits in the models as a reflection of patterns of health care

access among individual patients. We included rurality and other neighbourhood-based measures of socioeconomic factors because of their systemic potential to influence health care accessibility. We included comorbidity scores as a reflection of patients' overall health state, which may have influenced how they accessed care for specific conditions such as atopic dermatitis.

For each outcome model, we also included the patient's mean annual volume of that specific encounter type. For example, for the proportion of ED visits and hospitalizations associated with atopic dermatitis, we included each patient's mean annual number of all-cause ED visits and hospitalizations.

We conducted secondary analyses stratified by age (children v. adults) and sex. We conducted a series of sensitivity analyses for our primary outcome. First, we used log-binomial regression models fitted via generalized estimating equations (GEEs) to account for clustering at the LHIN level. Second, we considered counts of ED visits and hospitalizations as the outcome and used a GEE negative binomial regression model, which is suitable for overdispersed count data. Given the small number of clusters we used (14 LHINs), we also attempted to fit the GEE models with small-sample variance corrections.¹⁹ Finally, because seeing a dermatologist for atopic dermatitis is highly correlated with dermatologist density (Pearson correlation coefficient 0.9), we conducted a sensitivity analysis excluding that covariate from the model.

Ethics approval

As a prescribed entity under Ontario's privacy legislation, ICES is authorized to collect and use health care data for the purposes of health system analysis, evaluation and decision support. The use of administrative data in this project was authorized under section 45 of Ontario's *Personal Health Information Protection Act*, which does not require review by a research ethics board.

The use of EMRPC data for this project was approved by the Research Ethics Board at Sunnybrook Health Sciences Centre, Toronto, Canada.

Results

The estimated period prevalence (2005–2015) of atopic dermatitis was 3.1% (7812/249984). The prevalence was higher among children (4031/40705, 9.9%) than among adults (3781/209279, 1.8%). Patients with atopic dermatitis were younger than those without atopic dermatitis (mean age 26.8 yr v. 44.3 yr) and more likely to be female (60.2% v. 55.9%). On average, patients with atopic dermatitis also had more visits per year to their primary care physician (mean 7.9 v. 6.2). See Table 1 and Table 2 for more information.

Among patients with atopic dermatitis, we found 21 701 primary care visits, 185 specialist visits (including 32 dermatologist visits), 86 ED visits and 9 hospitalizations for atopic dermatitis between 2005 and 2015 (Appendix 1, Table S1 and Table S2).

Table 1 (part 1 of 2): Characteristics of patients in the EMRPC with and without atopic dermatitis, 2005 to 2015

Characteristic	No. of patients (%)*	
	Patients without atopic dermatitis <i>n</i> = 242 172	Patients with atopic dermatitis <i>n</i> = 7812
Age, yr		
Mean ± SD	44.3 ± 22.5	26.8 ± 23.5
Median (IQR)	46 (27–61)	16 (7–45)
Sex, female	135 379 (55.9)	4705 (60.2)
Rurality of residence†		
Rural	31 769 (13.1)	824 (10.5)
Small town	58 167 (24.0)	1613 (20.6)
Urban	150 150 (62.0)	5328 (68.2)
Neighbourhood income quintile†		
1 (low)	39 128 (16.2)	1338 (17.1)
2	44 457 (18.4)	1347 (17.2)
3	47 717 (19.7)	1594 (20.4)
4	51 021 (21.1)	1724 (22.1)
5 (high)	59 139 (24.4)	1789 (22.9)
Neighbourhood ethnic concentration quintile†		
1 (low)	46 896 (19.4)	1192 (15.3)
2	46 294 (19.1)	1309 (16.8)
3	54 681 (22.6)	1815 (23.2)
4	55 749 (23.0)	2041 (26.1)
5 (high)	36 685 (15.1)	1405 (18.0)
Neighbourhood dependency quintile†		
1 (low)	65 066 (26.9)	2508 (32.1)
2	55 219 (22.8)	1855 (23.7)
3	43 569 (18.0)	1329 (17.0)
4	34 572 (14.3)	1015 (13.0)
5 (high)	41 879 (17.3)	1055 (13.5)
Neighbourhood deprivation quintile†		
1 (low)	70 283 (29.0)	2227 (28.5)
2	53 646 (22.2)	1751 (22.4)
3	48 170 (19.9)	1535 (19.6)
4	36 795 (15.2)	1172 (15.0)
5 (high)	31 411 (13.0)	1077 (13.8)
Neighbourhood residential instability quintile†		
1 (low)	41 132 (17.0)	1345 (17.2)
2	47 436 (19.6)	1485 (19.0)
3	45 438 (18.8)	1431 (18.3)
4	46 896 (19.4)	1512 (19.4)
5 (high)	59 403 (24.5)	1989 (25.5)

Table 1 (part 2 of 2): Characteristics of patients in the EMRPC with and without atopic dermatitis, 2005 to 2015

Characteristic	No. of patients (%)*	
	Patients without atopic dermatitis <i>n</i> = 242 172	Patients with atopic dermatitis <i>n</i> = 7812
Continuity of primary care		
High (≥ 50% of visits to rostering physician)	169 327 (69.9)	4853 (62.1)
Low (< 50% of visits to rostering physician)	52 785 (21.8)	2162 (27.7)
Missing	20 060 (8.3)	797 (10.2)
Comorbidity (ADG)‡		
Low (0–4)	116 500 (48.1)	3407 (43.6)
Moderate (5–9)	98 418 (40.6)	3526 (45.1)
High (≥ 10)	27 254 (11.3)	879 (11.3)
Morbidity (RUB)‡		
Nonuser or healthy user	19 347 (8.0)	512 (6.6)
Low morbidity	48 192 (19.9)	1910 (24.4)
Moderate morbidity	122 641 (50.6)	3950 (50.6)
High morbidity	51 992 (21.5)	1440 (18.4)

Note: ADG = Adjusted Diagnosis Group, EMRPC = Electronic Medical Record Primary Care database, IQR = interquartile range, RUB = Resource Utilization Band, SD = standard deviation.
Characteristics are given for Dec. 31, 2015.
*Unless stated otherwise.
†Data for neighbourhood-level variables were missing for less than 1% of participants.
‡Based on Johns Hopkins Adjusted Clinical Groups; RUBs are aggregations of Adjusted Clinical Groups with similar expected utilization.

ED visits and hospitalizations

In the multivariable log-binomial regression model, higher dermatologist density was associated with a higher proportion of ED visits and hospitalizations for atopic dermatitis (Figure 1 and Table 3). One additional dermatologist per 100 000 population was associated with a 29% higher proportion of ED visits for atopic dermatitis (RR 1.29, 95% CI 1.05–1.57). In analyses stratified by age, we found a similar association for children (RR 1.34, 95% CI 1.06–1.70) but not for adults (RR 0.88, 95% CI 0.56–1.38). The association appeared accentuated among females (RR 1.51, 95% CI 1.11–2.06) compared to males (RR 1.12, 95% CI 0.85–1.46).

In the sensitivity analysis using GEE accounting for the cluster effect of LHINs, we found a small positive but non-significant association between dermatologist density and the proportion of ED visits and hospitalizations for atopic dermatitis (RR 1.09, 95% CI 0.88–1.35). When we used counts of ED visits and hospitalizations as the outcome, the GEE negative binomial regression model that used all covariates and allowed for clustering at the LHIN level did not converge because of a small number of cases and a lack of statistical power.

Table 2: Health service utilization of patients in the EMRPC with and without atopic dermatitis, 2005–2015

Variable	Patients without atopic dermatitis <i>n</i> = 242 172	Patients with atopic dermatitis <i>n</i> = 7812
ED visits per patient per year		
Mean ± SD	0.4 ± 0.6	0.5 ± 0.7
Median (IQR)	0 (0–0)	0 (0–1)
Hospitalizations per patient per year		
Mean ± SD	0.1 ± 0.2	0.1 ± 0.2
Median (IQR)	0 (0)	0 (0)
Primary care visits per patient per year		
Mean ± SD	6.2 ± 5.8	7.9 ± 6.6
Median (IQR)	5 (3–8)	6 (4–10)
Specialist visits per patient per year*		
Mean ± SD	0.1 ± 1.7	0.1 ± 1.1
Median (IQR)	0 (0)	0 (0)
Dermatologist visits per patient per year		
Mean ± SD	0 ± 0	0 ± 0.1
Median (IQR)	0 (0)	0 (0)

Note: ED = emergency department, EMRPC = Electronic Medical Record Primary Care database, IQR = interquartile range, SD = standard deviation. *Includes dermatologist visits.

After we removed variables whose coefficients did not converge (neighbourhood-level covariates, continuity of care, morbidity and comorbidity), we found a small positive but nonsignificant association between dermatologist density and the number of ED visits and hospitalizations (incidence rate ratio 1.12, 95% CI 0.81–1.53). GEE models with small-sample variance corrections did not converge with all covariates or with dermatologist density in the model.

Having seen a dermatologist for atopic dermatitis (RR 8.60, 95% CI 1.94–38.15) was associated with higher proportions of ED visits and hospitalizations for atopic dermatitis. Living in a small town (RR 0.12, 95% CI 0.03–0.43, v. urban residence) was associated with lower proportions of ED visits and hospitalizations. In our sensitivity analysis that excluded having seen a dermatologist for atopic dermatitis from the model, the results were essentially unchanged for the association between dermatologist density and the proportion of ED visits and hospitalizations (RR 1.28, 95% CI 1.05–1.57).

We found no significant associations between the various measures of neighbourhood socioeconomic status and marginalization and ED visits and hospitalizations for atopic dermatitis.

Other visit types

We found no association between dermatologist density and the proportions of overall physician visits (RR 0.99, 95% CI 0.98–1.00) or primary care visits (RR 1.00, 95% CI 0.99–1.01) for

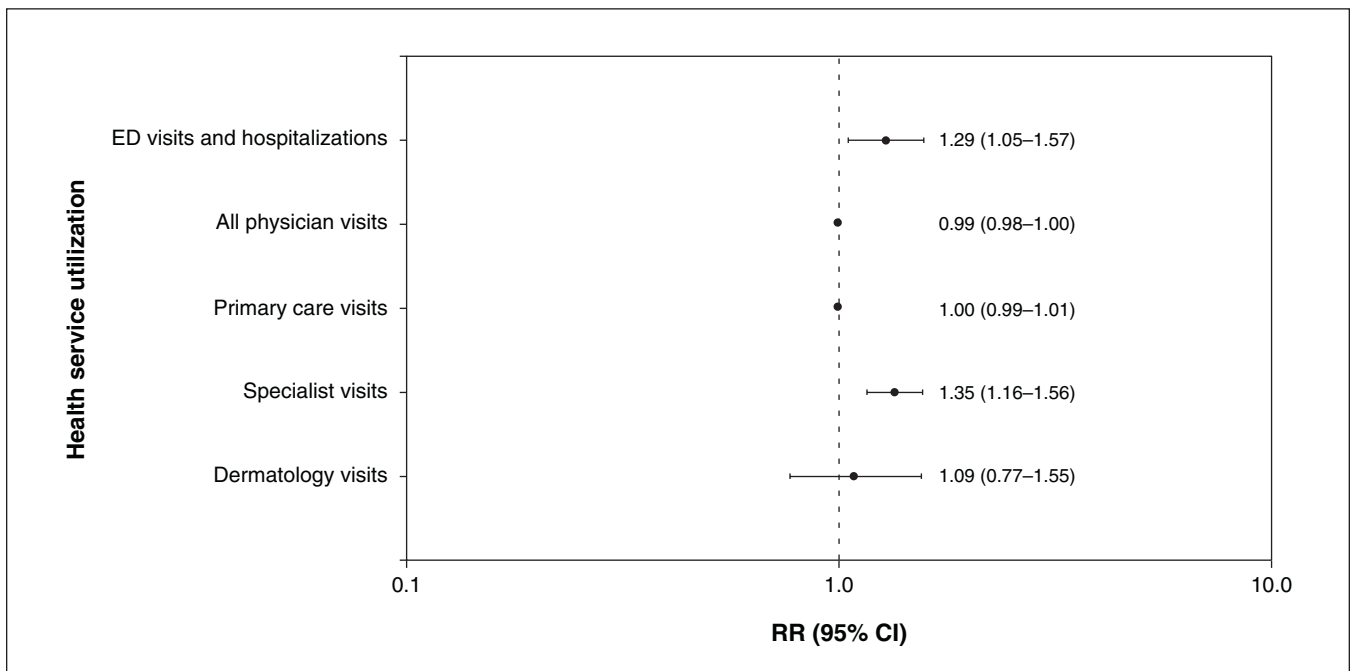


Figure 1: Association between dermatologist density and health service utilization for atopic dermatitis. Results are presented for multivariable log-binomial regression models to calculate risk ratios and 95% confidence intervals for associations between dermatologist density and the proportions of health care visits for atopic dermatitis: emergency department visits and hospitalizations; all physician visits; primary care visits; specialist visits (including dermatologist visits); and dermatology visits. We studied each outcome in a separate multivariable model that also included age (continuous), sex, continuity of primary care (in 2014/15; not rostered, low, high), whether the patient had seen a dermatologist for atopic dermatitis, rurality of residency, ACG comorbidity score (low [0–4], moderate [5–9], high [≥ 10]), ACG morbidity score (nonuser or healthy user, or low, moderate, high morbidity), neighbourhood income, dependency, deprivation, ethnic concentration and residency instability quintiles. For each outcome, we also included the patient’s mean annual volume of that specific encounter type. Note: ACG = Johns Hopkins Adjusted Clinical Group, CI = confidence interval, ED = emergency department, RR = risk ratio.

Table 3: Association between patient characteristics and proportion of ED visits and hospitalizations for atopic dermatitis in univariable and multivariable log-binomial regression models

Variable	Univariable RR (95% CI)	Multivariable* RR (95% CI)
Dermatologist density (per 1/100 000 increase)	1.22 (1.07–1.39)	1.29 (1.05–1.57)
Mean annual ED visits and hospitalizations	1.22 (1.11–1.35)	1.17 (1.04–1.31)
Low continuity of primary care (reference: high continuity)	1.61 (1.05–2.46)	1.17 (0.76–1.82)
Patient not rostered (reference: high continuity)	1.19 (0.56–2.51)	0.85 (0.39–1.84)
Age (per 1-year increase)	0.98 (0.97–0.99)	0.98 (0.97–0.99)
Female sex (reference: male)	0.62 (0.41–0.93)	0.72 (0.48–1.10)
Ever seen a dermatologist for atopic dermatitis	7.64 (1.91–30.60)	8.60 (1.94–38.15)
Small town residence (reference: urban residence)	0.11 (0.03–0.36)	0.12 (0.03–0.43)
Rural residence (reference: urban)	0.90 (0.58–1.40)	0.65 (0.24–1.76)
Low comorbidity (reference: high comorbidity)	1.23 (0.69–2.17)	0.47 (0.20–1.10)
Moderate comorbidity (reference: high comorbidity)	1.28 (0.76–2.16)	0.53 (0.28–1.02)
Nonuser or healthy user (reference: high comorbidity)	1.35 (0.31–5.95)	2.53 (0.47–13.58)
Low morbidity (reference: high morbidity)	2.67 (1.35–5.27)	4.71 (1.75–12.69)
Moderate morbidity (reference: high morbidity)	2.80 (1.56–5.02)	3.89 (1.87–8.09)
Income quintile 2 (reference: 1)	0.56 (0.31–1.01)	0.78 (0.38–1.57)
Income quintile 3 (reference: 1)	0.62 (0.36–1.07)	1.17 (0.51–2.64)
Income quintile 4 (reference: 1)	0.44 (0.23–0.84)	1.04 (0.39–2.81)
Income quintile 5 (reference: 1)	0.35 (0.17–0.70)	0.85 (0.26–2.77)
Dependency quintile 2 (reference: 1)	1.54 (0.85–2.76)	1.66 (0.89–3.07)
Dependency quintile 3 (reference: 1)	0.66 (0.30–1.45)	0.95 (0.42–2.18)
Dependency quintile 4 (reference: 1)	1.19 (0.60–2.36)	1.75 (0.81–3.78)
Dependency quintile 5 (reference: 1)	1.66 (0.93–2.98)	2.30 (1.07–4.93)
Deprivation quintile 2 (reference: 1)	1.23 (0.61–2.49)	1.04 (0.49–2.21)
Deprivation quintile 3 (reference: 1)	0.92 (0.44–1.92)	0.72 (0.31–1.68)
Deprivation quintile 4 (reference: 1)	2.44 (1.32–4.51)	1.45 (0.62–3.38)
Deprivation quintile 5 (reference: 1)	1.66 (0.84–3.29)	0.83 (0.31–2.20)
Ethnic concentration quintile 2 (reference: 1)	0.50 (0.24–1.04)	0.80 (0.35–1.83)
Ethnic concentration quintile 3 (reference: 1)	0.45 (0.22–0.94)	0.71 (0.25–2.00)
Ethnic concentration quintile 4 (reference: 1)	0.70 (0.38–1.31)	0.79 (0.28–2.28)
Ethnic concentration quintile 5 (reference: 1)	1.96 (1.17–3.29)	2.13 (0.73–6.23)
Instability quintile 2 (reference: 1)	0.56 (0.21–1.48)	0.56 (0.21–1.50)
Instability quintile 3 (reference: 1)	1.51 (0.71–3.18)	0.96 (0.41–2.25)
Instability quintile 4 (reference: 1)	1.41 (0.66–3.02)	0.83 (0.34–2.03)
Instability quintile 5 (reference: 1)	2.01 (0.99–4.05)	0.92 (0.35–2.46)

Note: CI = confidence interval, ED = emergency department, RR = risk ratio.

*Each multivariable model included dermatologist density (primary exposure, continuous); age (continuous); sex; continuity of primary care (2014–2015: not rostered, low, high); whether the patient had seen a dermatologist for atopic dermatitis; rurality of residence; Adjusted Clinical Group (ACG) comorbidity score (low [0–4], moderate [5–9], high [≥ 10]); ACG morbidity score (nonuser or healthy user, or low, moderate, high morbidity); and neighbourhood income, dependency, deprivation, ethnic concentration and residency instability quintiles.

atopic dermatitis. We did find increased proportions of specialist visits for atopic dermatitis with increasing dermatologist density (RR 1.34, 95% CI 1.16–1.56), but we found no apparent association between dermatologist density and the proportion of dermatology visits (RR 1.09, 95% CI 0.76–1.55). These findings did not differ substantially between children and adults.

Local Health Integration Networks

To characterize the relationship between local dermatologist density and each outcome further, we plotted the proportions of each outcome for each LHIN along with that LHIN's dermatologist density (Figure 2). Three LHINs in the Toronto area had among the highest proportions of ED

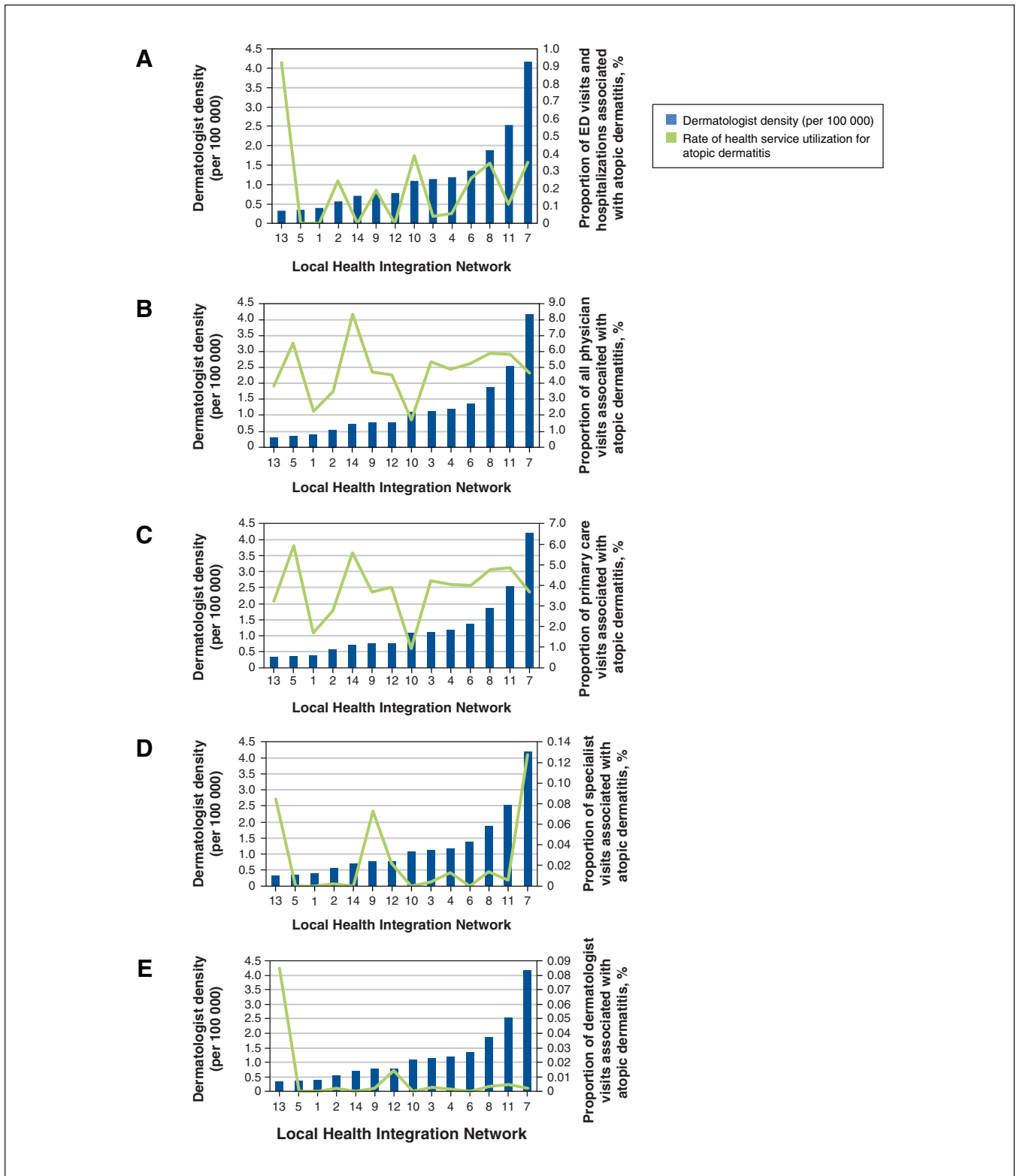


Figure 2: Proportions of health care visits associated with atopic dermatitis and dermatologist density by Ontario Local Health Integration Network: (A) emergency department visits and hospitalizations; (B) all physician visits; (C) primary care visits; (D) specialist visits (including dermatologist visits); and (E) dermatologist visits. Dermatologist density (per 100 000 population) is plotted using blue bars against the left y-axis; health service utilization for atopic dermatitis is plotted with green lines against the right y-axis. Local Health Integration Network numbers (x-axis): 1 = Erie St. Clair; 2 = South West; 3 = Waterloo Wellington; 4 = Hamilton Niagara Haldimand Brant; 5 = Central West; 6 = Mississauga Halton; 7 = Toronto Central; 8 = Central; 9 = Central East; 10 = South East; 11 = Champlain; 12 = North Simcoe Muskoka; 13 = North East; 14 = North West. Note: ED = emergency department.

visits and hospitalizations for atopic dermatitis; they also had relatively high dermatologist densities. Conversely, the Champlain LHIN (serving the Ottawa area) had the second-highest dermatologist density but among the lowest proportions of ED visits and hospitalizations for atopic dermatitis.

Interpretation

In this representative sample from Ontario, Canada, we found a period prevalence of atopic dermatitis of 3.1% between 2005 and 2015. Most visits for atopic dermatitis were to primary care (over 21 000 primary care visits compared to just 186 specialist visits, including dermatologist visits). Visits to the ED and hospitalizations for atopic dermatitis were uncommon (95 over the 11-year study period, 1.2 for every 100 patients). Contrary to our expectations, the proportions of ED visits for atopic dermatitis were not higher in areas with lower dermatologist densities.

The overall period prevalence for atopic dermatitis of 3.1% in our study was similar but somewhat lower than estimates from the Global Burden of Disease study,²⁰ which found that the prevalence of atopic dermatitis in Canada in 2017 was 4.4%. A survey study²¹ found the point prevalence of atopic dermatitis in adults to be 3.5% in Canada, higher than our period prevalence of 1.8% for adults in Ontario. Differences in methodology likely explain these discrepancies. Our algorithm had a sensitivity of 67%, which likely led to undercounted cases and a prevalence estimate lower than the true value.¹³ The Global Burden of Disease study and the survey study used administrative coding and patient-reported symptoms, respectively, to identify people with atopic dermatitis, which may have led to higher prevalence estimates than ours.^{20,21} Although we had access to health administrative data for Ontario, we have found that algorithms to identify atopic dermatitis using ICES administrative data performed inadequately (positive predictive value < 50%).¹³

Similar to other countries, we found that most care for atopic dermatitis was delivered in primary care,⁷ with few ED visits and hospitalizations.^{5,6} Dermatologist visits were uncommon, and lower per capita density of dermatologists was not associated with reduced ED visits and hospitalizations for atopic dermatitis. We expected that the increased availability of specialized care would have a preventive effect on use of the ED for what is largely an ambulatory disease. We have been careful not to overinterpret this finding, particularly given the considerable variation between LHINs with similar dermatologist densities and the low absolute number of ED visits and hospitalizations for atopic dermatitis. The LHINs in areas surrounding Toronto had higher proportions of ED visits and hospitalizations for atopic dermatitis than those in the Ottawa, Waterloo, Hamilton and Niagara regions, even though they had similar dermatologist densities. More ready and rapid access to dermatology care, regardless of local dermatologist density, could prevent some ED visits for atopic dermatitis. Any interventions aimed at decreasing ED visits and hospitalizations will need to be mindful of the local context in which they are being implemented.

Unlike in studies from the US,^{5,6} we did not find significant associations between measures of socioeconomic status and

ED visits and hospitalizations for atopic dermatitis. The health-systems differences between the 2 countries or our use of neighbourhood-level rather than individual patient measures of socioeconomic status could explain these findings. Having seen a dermatologist for atopic dermatitis was strongly associated with ED visits and hospitalizations, but in this cross-sectional study we did not assess temporality. A likely explanation is that people with more severe skin disease were more likely both to visit the ED and see a dermatologist.

Limitations

Limitations of our study included its cross-sectional design, which did not allow us to determine the temporal nature of the associations. The small number of some types of health care encounters used to calculate our outcomes may have made some estimates unreliable, particularly from the multivariable model; our findings should be interpreted with caution and replicated in larger samples.

Diagnostic codes to identify health care utilization for atopic dermatitis have not been validated for this purpose, but we applied them in patients with atopic dermatitis identified using a validated electronic medical record algorithm.¹³ Nevertheless, the low sensitivity of our algorithm to identify atopic dermatitis may have underestimated the prevalence of atopic dermatitis, and the moderate positive predictive value may have attenuated the true associations between our exposures and outcomes.

Our primary exposure, dermatologist density at the LHIN level, may not have accurately reflected access to a dermatologist and, in general, the geographical aggregations used could lead to ecological fallacy.

We were able to include data only up to 2015; changes in atopic dermatitis care and population-level health service utilization since then could affect the results of future analyses. In particular, effective systemic treatments have been approved for atopic dermatitis and have been shown to reduce hospitalizations related to atopic dermatitis; as well, the COVID-19 pandemic has led to delays in dermatologic care in Ontario.^{22,23}

Medication information in the EMRPC is limited, so we could not evaluate treatment patterns; furthermore, we may not have captured patients whose care was managed exclusively using over-the-counter treatments. Because some pediatric dermatologists in Ontario have a primary specialty designation of pediatrics, some visit types may have been misclassified.

Finally, although the EMRPC is representative of the population of Ontario, our study was limited to patients rostered to a family physician; people without access to a consistent family practice would have been excluded.

Conclusion

Emergency department visits and hospitalizations for atopic dermatitis were uncommon in Ontario. People with atopic dermatitis in Ontario are cared for predominantly by primary care physicians, making very few visits to dermatologists. Higher dermatologist density was not associated with lower ED utilization and hospitalization for atopic dermatitis; strategies to improve access to care for atopic dermatitis should be tailored to local contexts.

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Pharmaceuticals, Galderma, and Maine Pharma, and an advisory board member for Novartis, Boehringer-Ingelheim and Pfizer; she has served as an executive board member and chair of the communication committee of the Pediatric Dermatology Research Alliance, and chair of the strategic committee of the Society for Pediatric Dermatology. Karen Tu has received grants paid to her institution from St. Michael's Hospital Foundation, the College of Family Physicians of Canada, the Foundation for Advancing Family Medicine, the Canadian Medical Association Foundation, North York General Hospital, the Heart and Stroke Foundation of Canada, the Heart and Stroke Foundation of Ontario, the United States Department of Defense, the University of Toronto Department of Family and Community Medicine, the MaRS Innovation Fund, the Canadian Initiative for Outcomes in Rheumatology Care, Cancer Care Ontario, the Toronto Rehab Institute Chair Fund, UTOPIAN, the Arthritis Society, the Multiple Sclerosis Society of Canada, the Canadian Vascular Network and the Ontario SPOR Support Unit Targeted IMPACT Award. No other competing interests declared.

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Data sharing: The data set from this study is held securely in coded form at ICES. While legal data sharing agreements between ICES and data providers (e.g., health care organizations and government) prohibit ICES from making the data set publicly available, access may be granted to those who meet pre-specified criteria for confidential access, available at <https://www.ices.on.ca/DAS> (email: das@ices.on.ca). The full data set creation plan and underlying analytic code are available from the authors upon request, understanding that the computer programs may rely upon coding templates or macros that are unique to ICES and are therefore either inaccessible or may require modification.

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